Comparison of Measurements and Models in Stratospheric Polar Vortex Studies

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Abstract.
An overview will be given of recent studies comparing model results with observations of stratospheric meteorological and trace gas fields, focusing on the polar vortex during winter. Studies comparing process-oriented (e.g., stability) model, mechanistic (i.e., forced lower boundary near the tropopause) model and general circulation model (GCM) simulations of the dynamics of the polar winter stratosphere with analyzed or assimilated meteorological datasets are reviewed. The use of a heirarchy of models in comparing simulations of trace gas transport with observations will be discussed; these models include simple, but high-resolution, trajectory models, Lagrangian and Eulerian transport models, three-dimensional chemical transport models (CTMs), mechanistic models, and GCMs. The focus will be primarily on comparisons with satellite trace gas observations; satellite data that have recently been compared extensively with models include those from several limb emission instruments including the Cryogenic Limb Array Etalon Spectrometer (CLAES) and Microwave Limb Sounder (MLS) instruments on the Upper Atmosphere Research Satellite (UARS), and several solar occultation instruments, including the UARS Halogen Occultation Experiment (HALOE), the Polar Ozone and Aerosol Measurement (POAM) III instrument, and the Atmospheric Trace Molecule Spectroscopy (ATMOS) instrument. Comparisons of models with observations comprise detailed studies of specific events (e.g., stratospheric warmings and vortex evolution, wave events, lamination in trace gas profiles), climatological and/or statistical studies aimed at comparing general behavior, and studies aimed at identification or separation of mechanisms (e.g., stability modeling, separation of transport from chemical effects). Several examples will be given using different types of models (especially trajectory models and mechanistic models) and observation-based datasets (meteorological datasets, long-lived trace gas data from CLAES, MLS, ATMOS, POAM III and others) to study aspects of vortex development in fall and early winter and associated transport processes. These examples show typical "climatological" characteristics of the development of the polar vortex in fall and early winter, and several aspects of transport during the devolopment, including overall evolution of large-scale trace gas fields and lamination in trace gas profiles in and around the developing polar vortex. The use of vortex-centered coordinates (e.g., potential vorticity or equivalent latitude) in comparing models and observations will be emphasized; such coordinates are particularly useful in model initialization, and in comparing sparse datasets (such as those from solar occultation instruments) with global or hemispheric models.